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ABSTRACT

This paper focuses on the development of instruments to measure technology integration in learning environments. The model used as the basis for these instruments is the Technology Effectiveness Framework developed at the North Central Regional Educational Laboratory and described in "Designing Learning and Technology for Educational Reform" (B. Jones, J. Nowakowski, C. Rasmussen, and G. Valdez, 1994). Based on this model, the following instruments were developed: (1) a classroom observation instrument; (2) a teacher report of classroom observation; (3) teacher beliefs and practices instrument; (4) teacher technology use instrument; (5) student technology use instrument; and (6) a survey of technology infrastructures. Participants were teachers at 5 high schools at which 35 classroom observations were performed. After pilot testing of the instruments, the instruments were refined. The six instruments work together to produce a picture of how a teacher combines pedagogy and technology in a classroom with access to technology. The instruments are attached. (Author/SLD)

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Engaging Technology & Learning Opportunities
Technology Assessment Tools

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Abstract

This paper focuses on the development of instruments to measure technology integration in learning environments. The model used as the basis for these instruments is the Technology Effectiveness Framework developed at the North Central Regional Education Laboratory and described in Designing Learning and Technology for Educational Reform (Jones, Nowakowski, Rasmussen, & Valdez, 1994). Based on this model the following instruments were developed: 1) Classroom Observation instrument, 2) Teacher Report of Classroom Observation, 3) Teacher Beliefs and Practices, 4) Teacher Technology Use instrument, 5) Student Technology Use instrument, and 6) Survey of Technology Infrastructures.

As computers are added to classrooms across the nation, the inevitable cry arises for evidence that this investment pays off in increased student learning. In an attempt to produce such evidence, Kulik and Kulik (1991) performed a meta-analysis of 254 studies that looked at the impact of computer-based instruction (CBI). They concluded that ... "CBI generally produces positive effects on students. These effects include modest increases in student test scores and positive attitudes towards technology and teaching" (p. 80). Researchers also reported that use of technology decreased the amount of time needed for instruction.

Later, Hadley and Sheingold (1993) studied the ways in which teachers integrated computers into their classrooms. "Many of the teachers (88%) reported that such integration caused changes in their teaching practices including: increased expectations for students, increased individualization for students, conversion from a teacher-centered to a student-centered classroom, an increase in collaborative learning, and less time spent lecturing" (p.275). They also offered the observation that the impact of technology is dependent upon how it is used in the classroom.

Recent efforts to prescribe standards can be viewed as a way of establishing what ideal practice looks like. The benefit of establishing ideal practice is that it enables researchers to measure how far actual practice may be from the ideal. This provides a means of describing the variability of the learning environment from classroom to classroom.

Hirumi and Grau (1996) conducted a review of state standards, textbooks and journal articles that described necessary technology skills for teachers. They found little agreement with only 1 skill (basic computer operations) being listed by more than 70% of the sources.

The International Society for Technology in Education (ISTE) published National Education Technology Standards for Students (1998). Within that document they assert, "Certain conditions are necessary for schools to effectively use technology for learning, teaching and educational management" (p. 26). These necessary conditions include the support of "new learning environments" that would incorporate student centered learning, collaboration, use of multimedia, inquiry based learning, critical thinking, real-world activities, multiple paths for progression, and information exchange.

Jones, Valdez, Nowakowski and Rasmussen (1994) of the North Central Regional Educational Laboratory (NCREL) have chosen a two-pronged approach to describe the learning environment of the school. They have developed

an "Effective Technology" framework which describes the classroom environment in terms of engaged learning characteristics and the use of high performance technologies. These indicators include many of the same elements as the ISTE "new learning environments". Jones, Valdez, Nowakowski and Rasmussen, assert that "high-performance technology adds very substantial, qualitative differences to the learning environment that cannot be attained without that technology"(p. 4).

Method

This study grew out of a larger, multi-year investigation of technology integration in Iowa schools. During the first year of the study, thirty Iowa high schools were selected for a qualitative research effort to describe how technology was being used in high schools. This study resulted in thirty case studies which were used to select the five top technology-using schools from the thirty original participants. The selections were based on the Levels of Use and Stages of Concern scores using the Concerns Based Adoption Model by Gene Hall (1974) for each school as well as an examination of the case studies. This is reported in Selected perceptions of teachers and computer technology integration in Iowa high schools (Manternach-Wigans, L. K., 1999)

Participants in the current study were teachers at the five high schools identified as exemplary in technology integration during the 1997-1998 Star Schools project year, and teachers at five elementary schools from the same districts. For each school visited, the goal was to perform announced observations in two classrooms and drop-in observations in two classrooms. The final total for classroom observations was 35 of which 15 were unannounced observations. Copies of the teacher's beliefs and practices instrument was sent to teacher's who had agreed to have their classes observed. Researchers gave the forms to the teachers who were visited during drop-in observations.

Teachers and staff other than those who participated in the classroom observations were involved in the data collection process. The Survey of Technology Infrastructures was completed by the district technology coordinators. The Teacher Technology Use instrument was completed by teachers nominated by their principals as the top technology using teachers in their schools.

Results

1. The Classroom Observation (CO) instrument consists of 21 indicators. Nineteen of these indicators are rated 0 – 3.the last two are Technology Used and Software Used which are simply lists of the items observed in use during the lesson.

Internal Reliability Measure: The CO instrument was calculated to have a Cronbach Alpha of .88.

2. The Teacher Beliefs and Practices (TRI) consists of eleven open-ended questions designed to elicit teachers' beliefs and practices. Each question is scored with a separate rubric. Each rubric has a range of 0-3 points.

Internal Reliability Measure: The TRI instrument was calculated to have a Cronbach Alpha of .47. This is a marginally acceptable level considering that the instrument consists of only 11 items which are all open response questions and the number of cases is low (23).

Inter-rater Reliability: The 22 Teacher Beliefs and Practices were scored by 3 different researchers. The scores of the researchers were then compared to assess inter-rater reliability. Using a standard that a difference in scores that equals 1 or less is a match and a difference greater than one is a miss, the scores were compared for percent agreement. The percent agreement ranged from a low of 86% to a high of 90% with an average of 88% agreement.

3. The Survey of Technology Infrastructure (STI) consists of 13 open-ended questions that are scored with separate rubrics.

Internal Reliability Measure: The STI instrument was calculated to have a Cronbach Alpha of .83.

Inter-rater Reliability: The 10 STI instruments were scored by 3 different researchers. The scores of the researchers were then compared to assess inter-rater reliability. Using a standard that a difference in scores that equals 1 or less is a match and a difference greater than one is a miss, the scores were compared for percent agreement. The percent agreement ranged from a low of 89% to a high of 95% with an average of 92% agreement.

4. The Teacher Technology Use Survey (TTUS) consists of 91 questions organized into 4 different sub-scales. The sub-scales examine: how many times a teacher performs a specific technology-related task in a week, how many hours a teacher spends in these activities weekly, what proportion of the units taught annually include specific uses of technology, and what proportion of specific student activities are performed using technology. An open response question asked how technology has allowed the teacher to change teaching methodologies. Teachers are also asked to indicate if they need more training in specific areas and whether or not access issues prevent them from utilizing specific activities in the classroom.

Reliability Measure: This instrument has a calculated Cronbach Alpha of .86.

Discussion

Instrument Revisions

Following the pilot testing of these instruments, a number of changes were made. Both the Survey of Technology Infrastructures instrument and the Teacher Beliefs and Practices were rewritten as forced-choice survey instruments. The responses to the open-ended questions which were obtained during the pilot provided the alternatives for the forced-choice items.Other changes were minor and consisted of removing duplicates, adding missing elements, or changing the layout of the instruments.

Added Instrumentation

In order to establish the validity of the classroom observations, a Teacher Classroom Observation instrument was added to the battery. This instrument enables both the observer and the teacher to report on what happened during the observation. The agreement between the two scores will provide the basis for a cross validation between what the teacher is attempting to do in the classroom in terms of providing engaged learning opportunities and what is observed by a second party visiting the classroom.

An additional subsection has been added to the Student Technology Use instrument. This subsection is designed to assess where students encounter computers and graphing calculators (home or school), how many times and how many hours a week they spend in such pursuits, and how confident they are in their ability to use technology in different ways (a self-efficacy measure).

Instrument Function

These six instruments work together to provide a picture of how a teacher combines pedagogy and technology in a classroom where access to technology is available. The Teacher Beliefs and Practices instrument provides a means of identifying a teacher's beliefs and intentions regarding the use of technology in teaching and learning. The Classroom Observation instrument provides an independent observation concerning how these intentions and beliefs are made manifest in practice within the classroom. The Teacher Classroom Observation Report confirms the classroom observation. The Survey of Technology Infrastructure instrument provides a look at the infrastructure that supports technology use. The Teacher Technology Use instrument describes how deeply technology has penetrated into the work of the teacher. The Student Technology Use instrument indicates how much technology has entered into the work and play of students and how confident they are in its use.

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Researchers in schools, government organizations, and private foundations are all searching for a way to document the impact of technology on student learning outcomes. These instruments, by measuring the variability of classroom learning environments with respect to technology integration and engaged learning characteristics, and by providing individual student measures of technology use, will allow researchers to build and test models of student learning with technology as a mediating factor.

Instrument Use

- Classroom Observation Instrument.

This instrument can be used to describe specific classroom learning environments, as a check of reported classroom practices, and as a pre-post- assessment of technology usage. There are 21 indicators in total which focus on observable classroom artifacts and practices. Use of this instrument requires a trained observer and some means of recording scores. If used as part of a district-wide project, a bar code scanner is recommended for its ease of use and the elimination of the necessity to enter data into digital format

- Teacher Beliefs and Practices.

This instrument is designed to assess the teachers' pedagogical beliefs and typical classroom practices. In particular, it addresses issues that are not possible to observe in one classroom visit, e.g. What are the different ways groups are formed for collaborative work? This instrument could be used as part of a pre-post assessment of a training program designed to change these teacher practices.

- Teacher Technology Use.

The technology use survey is designed to measure the depth of penetration of technology into the teacher's work. It looks at the volume of time allocated to technology use as well as the proportion of units taught which include a variety of uses of technology. This instrument could be used as a pre-post assessment of teacher use of technology in a program of professional development and/or mentoring designed to increase technology integration.

- Survey of Technology Infrastructure

This instrument is used as part of the Engaged Learning/Technology assessment battery. It needs to be completed for each school involved in the study. It may be completed by the district tech coordinator or building level information specialist/tech coordinator. This instrument is used to collect data regarding the technology infrastructure that supports classroom integration of technology. The ratings from this instrument will be the same for all classrooms within the school unit that have access to its resources.

- Teacher Report of Classroom Observation

The teacher report is a validation of the Classroom Observation and can be used as the basis for a conference if great disparity is noticed between the two reports of a single classroom activity.

- Student Technology Use Survey

This instrument measures the penetration of technology into the life of the student by asking how many times a week and how many hours a week the student uses computers or graphing calculators for specific types of activity. The instrument also includes a sub-scale for self-efficacy with computers and graphing calculators. The results of this instrument can be used to show the variation in student experience and confidence in using computers and graphing calculators.

To obtain a matrix score of engaged/passive learning and high/low technology (Jones, Valdez, Nowakowski, & Rasmussen, (1994), four instruments must be used: Classroom Observation Instrument, Teacher Beliefs and Practices, Teacher Technology Use Survey, and the Survey of Technology Infrastructure.

Specimen Set

The following are sample questions taken from each of the Engaged Learning/Technology instruments. They are intended to show the type of questions asked and the scope of each instrument.

Classroom Observation Instrument

C01 - ACTIVE ENGAGEMENT

Are the teacher/student, student/student actively engaged with each other and with instructional resources? Is the teacher creating learning opportunities that stimulate thought and enquiry? [E.g.(including, but not limited to the following) linking to external sources of info such as museums, other students, experts, examining contrasting data or viewpoints, use of rich media sources to create presentations – images, audio, video, 3-D, virtual reality.]

C09 TEACHER/FACILITATOR

Is technology being used by the teacher to create a learning environment where he/she is a facilitator? The facilitator role will be evidenced by the teacher giving the assignment, providing or preparing needed resources and being available for questions. When a problem occurs, the facilitator asks questions that lead a student to the solution of the problem. This would not include teachers who step in and solve the problem for the youngster.

C11 DEVELOP PRODUCTS

Are students using technology to develop products they can use or share with others? This could be commercials to advertise particular books, databases to share with other students, or posters created on computer to illustrate advertising techniques.

C19 DIFFERENT ACCESS POINTS

Does software offer different routes through the program, different levels to match learner proficiency? Are there different types of help for both novice and experienced teachers and students?

Teacher Report of Classroom Observation

C01 - ACTIVE ENGAGEMENT

Are the teacher/student, student/student actively engaged with each other and with instructional resources? Is the teacher creating learning opportunities that stimulate thought and enquiry? [E.g.(including, but not limited to the following) linking to external sources of info such as museums, other students, experts, examining contrasting data or viewpoints, use of rich media sources to create presentations – images, audio, video, 3-D, virtual reality.]

C09 TEACHER FACILITATOR

Is technology being used by the teacher to create a learning environment where he/she is a facilitator? The facilitator role will be evidenced by the teacher giving the assignment, providing or preparing needed resources and being available for questions. When a problem occurs, the facilitator asks questions that lead a student to the solution of the problem. This would not include teachers who step in and solve the problem for the youngster.

C17 DEVELOP PRODUCTS

Are students using technology to develop products they can use or share with others? This could be commercials to advertise particular books, databases to share with other students, or posters created on computer to illustrate advertising techniques.

C19 DIFFERENT ACCESS POINTS

Does software offer different routes through the program, different levels to match learner proficiency? Are there different types of help for both novice and experienced teachers and students?

Survey of Technology Infrastrucure

Access

1. What type of network connections are present in the school? Please check all that apply.

___ No network connections present
___ LocalTalk network, 235 Kbps
___ EtherTalk (10 Mbs ethernet), 10Base T (data plus phone)
___ Ethernet, 100base T
___ Other, please explain _____

Operability

1. What is the capability to exchange data among diverse technologies used? Please select the BEST answer.

___ No provision for data to be exchanged among diverse technologies.
___ Students & teachers use "text only" format to enable data exchange.
___ All computers run same cross-platform programs (Word, Excel, etc.)
___ In addition to using cross platform applications, translation software is available on all computers. (e.g. MacLink, Conversions Plus)

Resource organization?

1. Are resources centralized or decentralized (distributed)? (resources such as CD-ROMs, videos, hardware, software, others?) Please check BEST answer.

___ Stand alone computers only, software loaded on as-needed basis, Tech Coordinator controls access to software
___ Centralized resources, have LAN software collected in media center; may or may not have Internet connection in media center and or labs.
___ LAN and WWW, teachers may have folders on server; teachers may have content-specific software; classrooms, media centers, and labs are connected to WWW
___ LAN, WAN, and WWW, teachers and students have folders on server; CD Towers enable simultaneous sharing of resources by a number of classrooms; classrooms and schools connected through LAN and WAN. Internet available at every computer
___ other, please explain _____

Teacher Beliefs and Practices

1. How are your students involved in setting goals, developing assessments and setting standards for learning tasks? Please check the BEST answer.

___ Goals primarily set through curriculum teacher
___ Mixture of student, teacher, and curriculum used to set goals, students may participate in developing rubrics used for assessment.
___ Teacher facilitates as students decide how to meet curriculum guide lines students devise activities and rubrics to asses them
___ Other, please explain _____

5. How are learning tasks selected? Please check the BEST answer.

___ Teacher selects all tasks or uses textbook; same tasks for everyone.

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___ Use curriculum guidelines strictly, may consider student preferences, strengths, weaknesses, etc. May include choice between alternatives.
___ Students have input in selecting tasks for learning; may choose from a menu of alternatives, or devise own activities. Curriculum used as a guide.
___ Other, please explain _____

8. Describe tasks projects that required information from another discipline for completion. Please check the BEST answer.

___ No planning for cross discipline studies
___ Specific tasks may use skills from other disciplines(e.g. writing in mathematics or using measuring skills in chemistry
___ Small thematic projects are planned that incorporate other disciplines (e.g.reports requiring library and writing skills, book reports in history class, creating databases in social studies.)
___ Major learning segments of the class are thematic units or problem-based learning that require the integration of multiple areas of study. (e.g. Designing a zoo including the requirements for food, shelter, companionship, exercise, etc. for each animal.)
___ Other, please explain _____

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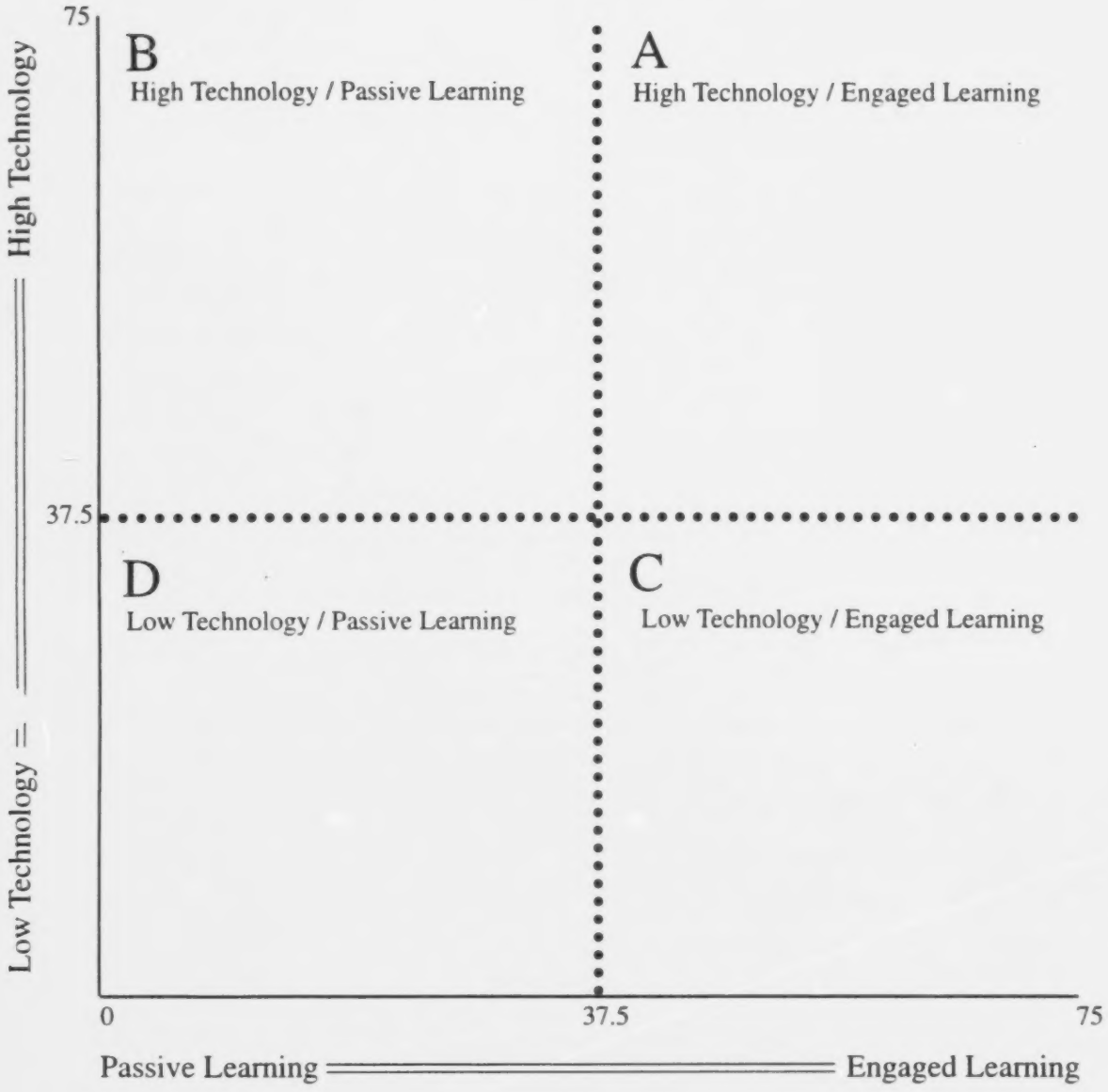
Scoring Matrix for High Performance Technology Framework *



* Modified from scoring matrix created by NCREL

Survey of Technology Infrastructure

Access

1. What type of network connections are present in the school? Please check all that apply.

___ No network connections present
___ LocalTalk network, 235 Kbps.
___ EtherTalk (10 Mbs ethernet), 10Base T (data plus phone)
___ Ethernet, 100base T
___ Other, please explain _____

2. What type of Internet connection is used by the school? Please check BEST answer.

___ No Internet
___ Dial-up connection
___ 56 K dedicated line
___ T1 or higher dedicated line
___ Other, please explain _____

3. How many connections to the Internet can be sustained simultaneously? Please check BEST answer.

___ No connections
___ Some (at least 1) computer(s) in the school have access
___ Nearly every computer in school has access
___ At least every computer in school is connected, may have excess capacity

4. How far do teachers and students have to go to access diverse technologies (e.g. computer, printer, scanner, Internet connection, digital camera)? (classroom, next floor, next building, media center?) Please check BEST answer.

___ None available
___ Available within the district
___ Available within the building
___ All technologies available in the classroom or nearby

5. Briefly describe the extent to which technology is being used at this school. Please check BEST answer.

___ No use of technology
___ Few proficient users, more non-users
___ Many emergent users, some proficient, some reluctant
___ Many proficient users, no non-users

6. What provisions have been made to ensure equitable use/access of hardware and software for all students and teachers? Please check BEST answer.

___ Not addressed
___ Teachers responsible for ensuring students have equal access to technologies.
___ Policy/plan for ensuring equal access is in place.
___ Well-established policies are applied to ensure equitable access to students including open labs before, after, and during school times. May have laptops or word processors for check-out to students.

7. Do students who are not enrolled in computer based courses have the same access as those who are? Please check the BEST answer.

___ No acces outside of class time.
___ Limited access (short periods of time before/after school ; may be media center only)
___ Well established access (labs/classrooms/& media center open at least 1 hr before/after school, most school computers included.)
___ Other, please explain _____

Operability

1. What is the capability to exchange data among diverse technologies used? Please select the BEST answer.

___ No provsion for data to be exchanged among diverse technologies.
___ Students& teachers use "text only" format to enable data exchange.
___ All computers run same cross-platform programs (Word, Excel, etc.)
___ In addition to using cross platform applications, translation software is available on all computers. (e.g. MacLink, Conversions Plus)

2. Can groups of teachers or students share documents and data simultaneously? Please check BEST arswer.

___ No
___ Yes, limited availability
___ Yes, not often used
___ Yes, commonly, used
___ Other, please explain _____

3. Describe the periods of downtime delays experienced by the system. Please check BEST answer.

___ Down more than working, difficult to use
___ Frequently down, sluggish, long repair times
___ May occasionally be down, or sometime take awhile to fix
___ Rarely down, readily repaired

4. Are users able to operate the system easily? Please select the BEST answer.

___ No
___ Yes, some
___ Yes, many
___ Yes, most

Resource organization?

1. Are resources centralized or decentralized (distributed)? (resources such as CD-ROMs, videos, hardware, software, others?) Please check BEST answer.

___ Stand alone computers only, software loaded on as-needed basis, Tech Coordinator controls access to software
___ Centralized resources, have LAN software collected in media center; may or may not have Internet connection in media center and/or labs.
___ LAN and WWW, teachers may have folders on server; teachers may have content-specific software; classrooms, media centers, and labs are connected to WWW
___ LAN, WAN, and WWW, teachers and students have folders on server; CD Towers enable simultaneous sharing of resources by a number of classrooms; classrooms and

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schools connected through LAN and WAN. Internet available at every computer
___ other, please explain _____

2. Can users provide resources to the system on demand? Please check BEST answer

___ No resources may be added to the system
___ Yes, Tech coordinators only may add information
___ Yes, staff may add information
___ Yes, staff and students may freely add information
___ Other, please explain _____

3. Is the system designed to facilitate communication among users with diverse technologies to carry out collaborative projects? Please check BEST answer.

___ No
___ System is capable of use for collaborative projects, but not enabled
___ System is used for collaborative projects by a select group or used sometimes
___ Yes, system freely available for collaborative projects
___ Other, please explain _____